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THE WORK OF THE BELLE FOURCHE RECLAMATION PROJECT EXPERIMENT FARM IN 1914.[1]

By Beyer Auxe, *Farm Superintendent.*

INTRODUCTION.

The work of the Belle Fourche Experiment Farm consists of a number of field-crop experiments, both with and without irrigation. From 1907 to 1911 all the experiments were conducted on dry land. Irrigation water was first brought to the farm in 1912, when experiments under irrigation were commenced. The work of the farm includes experiments with grain and forage crops, tests of vegetables, orchard, and shade trees, and a number of rotation and tillage experiments, both on dry land and with irrigation. The arrangement of the fields and the location of the experiments in 1914 are shown in figure 1.

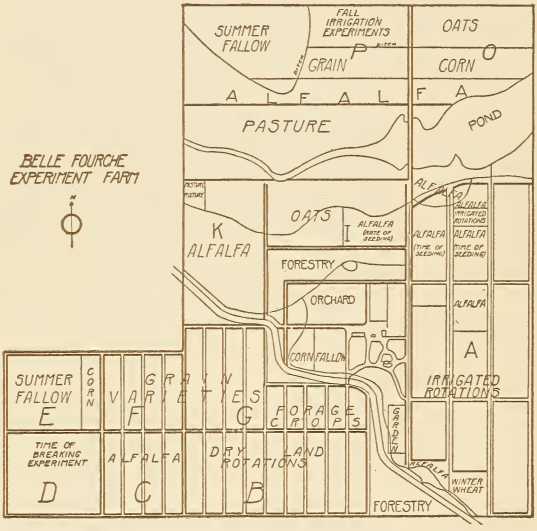

Fig. 1.—Diagram of the Belle Fourche Experiment Farm, showing the arrangement of the fields and the location of the crop experiments in 1914. (P-5621-W. I. A.)

[1] The Belle Fourche Experiment Farm consists of 280 acres of land on the Belle Fourche (S. Dak.) reclamation project, of which 160 acres were set aside by Executive order and 120 acres were withdrawn from entry by the Department of the Interior for use as an experiment farm. There are 240 acres under cultivation, 90 acres dry land and 150 acres irrigated. The farm is operated by the Bureau of Plant Industry of the United States Department of Agriculture and is in charge of the Office of Western Irrigation Agriculture. A farm superintendent detailed by that office has general supervision of the experiments.

Reports of the work of this farm in 1912 and 1913 are published in Bureau of Plant Industry Circular 119, issued Mar. 29, 1913, and in an unnumbered circular of the Office of Western Irrigation Agriculture, issued Sept. 8, 1914, entitled "The Work of the Belle Fourche Reclamation Project Experiment Farm in 1913."

CONDITIONS ON THE PROJECT.

CLIMATIC CONDITIONS.

The season of 1914 was very favorable to crop production, and the crop yields obtained on the experiment farm, as well as by the farmers on the project, were above the average of previous years. While the total rainfall for the year, 11.70 inches, was below the average for the past seven years, it was timely and of sufficient quantity to permit good plant growth up to June 15. From this time to October 15 there were only showers. The number of clear days was above the average. The last spring frost was on May 12 and the first fall frost on October 4, making a frost-free period of 145 days, which was 8 days more than the average for the past seven years. The season was ideal for growing crops under irrigation, and irrigation water could be had at all times. Table I presents a summary of the climatological observations made at the experiment farm from 1908 to 1914, inclusive.

TABLE I.—*Summary of climatological observations at the Belle Fourche Experiment Farm, 1908 to 1914, inclusive.*

PRECIPITATION (INCHES).

Year, etc.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1908	0.20	0.19	1.65	1.16	3.95	1.47	1.26	0.62	0.52	2.03	0.20	0.91	14.16
1909	.17	.23	.19	.84	3.87	5.59	2.45	.55	1.07	.76	.73	1.28	17.73
1910	.73	.70	.93	1.57	1.26	1.51	1.42	1.03	2.92	.27	.11	.10	12.25
1911	.13	.05	.09	.17	.45	.50	.80	1.86	.92	.39	.98	.30	6.64
1912	.24	.10	.71	2.32	2.26	.29	3.20	2.80	3.49	.51	.04	.13	16.09
1913	.57	.24	.99	.25	1.98	3.10	.35	.26	2.38	1.86	.10	.45	12.53
1914	T'ce.	1.00	.29	1.09	2.22	2.09	1.34	1.12	.35	1.77	.....	.43	11.70
Average	.29	.36	.69	1.06	2.27	2.08	1.55	1.18	1.66	1.08	.31	.51	13.01

EVAPORATION (INCHES).

1908	.....	.....	.....	5.53	5.92	6.82	8.08	7.87	6.75	.....	.....	.....	40.97
1909	.....	.....	.....	3.65	6.42	5.86	7.70	8.25	5.00	.....	.....	.....	36.88
1910	.....	.....	.....	5.41	5.31	8.98	10.42	7.30	4.31	.....	.....	.....	41.73
1911	.....	.....	.....	4.65	8.30	10.24	10.71	6.68	6.11	.....	.....	.....	46.69
1912	.....	.....	.....	4.85	6.42	8.18	7.92	6.60	3.71	.....	.....	.....	37.74
1913	.....	.....	.....	4.71	4.30	7.05	8.24	8.14	4.71	.....	.....	.....	37.15
1914	.....	.....	.....	3.37	5.13	6.71	8.74	6.97	4.19	.....	.....	.....	35.11
Average	.....	.....	.....	4.60	5.97	7.69	8.83	7.40	4.97	.....	.....	.....	39.47

WIND VELOCITY (MILES PER HOUR).

Mean:													
1908	.....	.....	.....	.....	8.3	7.2	5.0	6.8	6.5	.....	.....	.....	.....
1909	.....	.....	.....	9.1	10.1	6.2	6.0	5.6	5.7	6.3	5.5	.....	.....
1910	.....	.....	6.3	9.2	8.2	9.3	7.7	6.6	6.2	7.1	6.5	9.2	.....
1911	7.5	5.8	9.6	9.2	11.6	9.1	7.9	7.3	7.7	.....	10.0	7.6	.....
1912	6.9	7.3	6.6	9.5	11.1	7.6	6.0	6.9	7.6	.....	.....	.....	.....
1913	.....	.....	.....	6.2	5.9	6.8	5.8	5.1	4.5	.....	.....	.....	.....
1914	.....	.....	.....	8.2	7.7	6.7	5.0	5.0	6.2	.....	.....	.....	.....
Maximum:													
1908	.....	.....	.....	.....	19.6	12.1	12.9	9.0	13.8	.....	.....	.....	.....
1909	.....	.....	.....	26.8	21.7	12.9	11.6	11.8	9.8	13.8	15.0	.....	.....
1910	.....	.....	18.9	23.8	22.0	19.4	17.6	17.6	12.1	18.3	16.7	28.0	.....
1911	18.8	11.4	19.6	18.6	19.4	20.7	19.4	15.2	15.9	.....	21.7	15.0	.....
1912	17.5	16.7	18.8	24.9	25.3	17.5	10.0	12.4	26.3	.....	.....	.....	.....
1913	.....	.....	.....	16.5	12.4	18.9	14.4	9.0	13.8	.....	.....	.....	.....
1914	.....	.....	.....	15.6	23.0	15.1	9.9	13.1	14.5	.....	.....	.....	.....

TABLE I.—*Summary of climatological observations at the Belle Fourche Experiment Farm, 1908 to 1914, inclusive*—Continued.

WIND VELOCITY (MILES PER HOUR)—Continued.

Year, etc.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Minimum:													
1908	.....	.....	.....	.....	2.1	1.7	2.5	2.9	.....	.....	.....	.....	.....
1909	.....	.....	.....	2.5	2.6	2.9	2.5	2.5	2.5	2.1	.9	.....	.....
1910	.....	.....	1.7	3.1	1.6	3.1	3.0	2.9	2.2	2.5	2.5	1.8	.....
1911	1.2	.8	2.4	3.3	3.9	4.5	2.8	2.6	2.5	.....	1.3	2.1	.....
1912	.8	2.1	1.8	3.0	2.9	2.8	3.0	2.1	1.5	.....	.....	.....	.....
1913	.....	.....	.....	1.3	1.2	2.4	1.7	1.9	.9	.....	.....	.....	.....
1914	.....	.....	.....	4.0	2.0	2.9	1.6	2.1	2.2	.....	.....	.....	.....

MONTHLY TEMPERATURE (°F.).

Mean:													
1908	.....	.....	.....	48	52	63	73	68	64	45	37	22	.....
1909	12	23	32	38	52	66	70	75	61	46	21	10	.....
1910	18	8	46	51	52	68	76	68	59	51	31	25	.....
1911	20	22	39	42	58	73	71	65	59	43	25	20	.....
1912	12	25	19	47	55	66	70	68	52	45	38	28	.....
1913	13	17	23	48	53	66	70	74	59	42	37	23	.....
1914	27	14	33	43	55	65	76	69	62	49	39	15	.....
Maximum:													
1908	.....	.....	.....	89	79	90	100	101	105	82	75	49	.....
1909	50	51	65	73	84	95	100	105	96	84	73	49	.....
1910	45	46	87	89	81	108	109	101	97	91	67	52	.....
1911	59	61	78	88	90	101	105	100	94	82	58	51	.....
1912	44	49	70	78	84	101	94	95	94	85	70	57	.....
1913	48	62	54	89	95	98	101	104	97	80	64	51	.....
1914	61	60	70	78	85	98	104	102	101	88	71	48	.....
Minimum:													
1908	.....	.....	.....	5	29	39	43	39	22	22	0	−12	.....
1909	−24	−19	12	6	22	45	41	45	31	11	− 7	−23	.....
1910	−19	−26	22	24	27	36	44	32	30	13	8	−13	.....
1911	−22	− 7	8	7	23	43	41	32	35	− 1	− 8	−25	.....
1912	−32	−12	−15	22	32	39	40	47	24	22	11	2	.....
1913	−32	−14	−20	24	26	45	42	45	29	14	14	− 1	.....
1914	− 1	−28	4	8	30	44	48	40	35	25	9	−21	.....

KILLING FROSTS.

Season.	1908	1909	1910	1911	1912	1913	1914	7-year average.
Last in spring	May 21	May 18	May 21	May 12	May 4	May 6	May 12	.....
First in fall	Sept. 22	Sept. 24	Sept. 26	Oct. 4	Sept. 25	Sept. 24	Oct. 4	.....
Frost-free period (days)	128	128	127	146	144	141	145	137

CROP CONDITIONS.

The area of land devoted to field crops on the Belle Fourche project in 1914 was larger by 4,603 acres than in 1913, an increase of about 12 per cent. The total irrigated area of the 615 farms on the project in 1914 was 37,454 acres. Of this, a total of 745 acres was devoted to young alfalfa and miscellaneous crops not harvested, so that the area from which crops were harvested aggregated 36,709 acres. During the year 4,940 acres were seeded to alfalfa, of which 4,301 acres were seeded with a nurse crop and 639 acres without a nurse crop. In 1913 there were 13,096 acres planted to wheat, as against 7,885 acres in 1914, and there were 1,859 acres in corn in 1913 and 4,415 acres in 1914. Most encouraging signs of better farming are to be

seen in the decreased acreage in wheat and the increased acreage planted to alfalfa and corn and in the increase in the area devoted to pasture, which was 285 acres in 1913 and 3,604 acres in 1914. These changes are associated with a marked increase in the number of live stock on the project.

The acreage, yields, and farm values of the crops produced on the project in 1914 are stated in Table II, the figures being obtained from the United States Reclamation Service.

TABLE II.—*Acreage, yields, and farm values of the crops produced on the Belle Fourche project in 1914.*

Crop.	Area (acres).	Unit of yield.	Yield.			Farm value.		
			Total.	Per acre.		Per unit of yield.	Total.	Per acre.
				Average.	Maximum.			
Alfalfa hay	9,745	Ton	20,473	2.1	4.9	$4.50	$92,129	$9.46
Alfalfa seed	1,416	Bushel	3,205	2.3	6.7	7.30	23,397	16.51
Barley	1,448	do	34,718	24.0	66.7	.70	24,303	16.77
Beans	42	do	314	7.5	30.0	3.00	942	22.41
Beets, sugar	37	Ton	247	6.7	15.0	4.00	988	26.75
Clover hay	52	do	47	0.9	1.0	5.00	235	4.52
Clover seed	9	Bushel	14	1.5	2.0	7.00	98	10.50
Corn	4,415	do	106,280	24.1	66.0	.70	74,396	16.85
Corn fodder	880	Ton	1,159	1.3	5.8	5.00	5,804	6.61
Garden	159						8,036	50.55
Hay, native	2,236	Ton	1,911	0.9	5.0	10.00	19,110	8.55
Millet seed	58	Bushel	889	15.3	31.8	1.00	889	15.32
Oats	6,392	do	209,813	32.8	87.0	.40	83,925	13.12
Pasture	3,604						12,078	3.25
Potatoes	195	Bushel	19,796	101.5	249.0	.80	15,837	81.15
Rye	14	do	244	17.4	20.0	.90	220	15.71
Wheat	7,885	do	108,880	13.8	42.5	.90	97,992	12.41
Miscellaneous	45						809	17.98
Less duplicated areas	1,923							
Total	36,709						461,188	
Average								12.56

Table III shows the live stock on hand January 1, 1914, and on December 31, 1914, their value, and also the increase in total values. These figures were obtained from the United States Reclamation Service. Beef cattle were not segregated from dairy cattle in the inventory taken January 1.

TABLE III.—*Inventory of stock on the Belle Fourche project in 1914.*

Item.	Inventory, January 1.			Inventory, December 31.			Increase in total value.
	Number.	Value.	Total value.	Number.	Value.	Total value.	
Horses	2,400	$90.32	$224,891	2,848	$87.50	$249,150	$24,259
Mules	80	83.65	7,445	59	112.10	6,635	−810
Cattle:							
Beef	2,758	46.12	127,214	2,514	46.50	116,901	80,816
Dairy				1,578	57.75	91,129	
Sheep	12,872	3.76	48,471	25,740	3.76	96,782	48,311
Hogs	4,636	8.75	40,576	11,988	8.97	107,772	67,196
Fowls	23,125	.46	10,586	29,186	.49	14,252	3,666
Beehives	139	5.76	801	129	6.20	801	
Total			459,984			683,422	223,438

The hog industry has progressed more rapidly than that of any other live stock during the year, showing an increase of 158.5 per cent. Pasturing hogs on alfalfa and hogging corn are coming very much into favor. Dairying is also developing rapidly. During the year it is estimated that about 200,000 pounds of butter fat were produced and shipped from the project.

The number of sheep has more than doubled during the year, and sheep feeding has been found to be a fairly profitable way of disposing of alfalfa hay. A cooperative creamery was built at Newell and made a good showing for the first season. The agricultural tendencies are toward feeding more of the crop grown on the farm and selling live-stock products.

EXPERIMENTS IN CROP ROTATION.[1]

In the spring of 1912 a series of 32 rotations under irrigation was started. These rotation experiments are conducted on quarter-acre plats in field A. The crops used are as follows: Alfalfa, 21 plats; sugar beets, 15 plats; corn, 7 plats; spring wheat, 5 plats; winter wheat, 2 plats; oats, 18 plats; barley, 2 plats; flax, 3 plats; potatoes, 13 plats; and clover, 1 plat.

These crops are grown in various sequences, including eleven 2-year rotations, three 3-year rotations, four 4-year rotations, and five 6-year rotations. In addition to this, nine plats are used for continuous cropping to each of the crops used in the rotations.

Table IV gives the maximum, minimum, and average yields of all the plats of each crop used in the rotations in 1914. A comparison of the yields for the three years that these experiments have been running is also shown.

TABLE IV.— *Yields of the crops grown in the irrigated rotation experiments at the Belle Fourche Experiment Farm in 1912, 1913, and 1914.*

Number of plats.	Crop.	Yields per acre, 1914.			Comparison of average yields per acre.		
		Maximum.	Minimum.	Average.	1912	1913	1914
20	Alfalfa (includes 8 plats newly seeded)....tons..	5.14	1.56	3.0	(2)	2.6	3.0
15	Sugar beets....do....	14.6	6.4	11.6	7.6	7.8	11.6
6	Corn....bushels..	52.1	32.5	43.6	28.7	34.0	43.6
5	Spring wheat....do....	42.0	19.2	25.7	22.1	19.9	25.7
2	Winter wheat....do....	29.4	16.4	22.9	(3)	11.3	22.9
18	Oats....do....	109.6	25.5	78.8	51.9	39.0	78.8
1	Barley....do....	31.7	31.7	31.7	28.0	14.8	31.7
3	Flax....do....	21.4	7.5	14.8	13.6	13.4	14.8
13	Potatoes....do....	139.6	68.0	105.9	45.5	112.5	105.9
1	Clover....tons..	.44	.44	.44	.....	(4)	.44

[1] These experiments are under the direct supervision of Mr. John B. Wentz, assistant, who prepared the report here given.
[2] Not harvested.
[3] The rotations were not started until the spring of 1912, so there was no winter wheat in that year.
[4] A stand of clover was not obtained until 1914.

One point of interest in connection with the sugar beets is the high sugar content that was obtained this year and in 1913. The average sugar content of the beets for the three years 1912, 1913, and 1914, was 14.8, 19.1, and 22.1 per cent, respectively.[1]

The average yield of alfalfa in Table IV includes the yields of the spring-sown alfalfa. The average yield of the plats sown in 1912 was 3.69 tons per acre, that of the plats sown in 1913 was 3.73 tons per acre, and that of the spring-sown alfalfa was 1.93 tons per acre.

Table IV shows a decided increase in yield in 1914 over the preceding seasons in all crops except potatoes. The highest potato yield was obtained in 1913.

These rotation experiments have not been running long enough to warrant the statement that any one rotation is better than another, but in a few cases the effects of the previous crop upon that following seem to be significant.

Beets after oats (manured) have given a higher average yield for the three years than beets after oats without manure. The difference, though, in favor of manured oats was not large until 1914, when the average of the plats after the manured oats was 1.3 tons higher than the average of the plats after oats without manure.

Corn after beets has shown a decided effect of the preceding crop. In the seasons of 1913 and 1914 corn after beets had an unhealthy appearance during the early part of the summer and the yields obtained were comparatively low.

Potatoes after manured beets have shown an increase in yield over potatoes after beets without manure, while potatoes after manured oats have not yielded any higher than potatoes after oats without manure.

Spring wheat after alfalfa has produced high yields all three years.

PASTURING ALFALFA.

One of the 6-year rotations, No. 65, including corn, flax, oats, and three years of alfalfa, has been planned so that the third-year alfalfa each year is pastured by hogs until the corn is ripe, and then the hogs are turned into the corn. In the spring of 1914 six fall pigs, weighing an average of 103.3 pounds, were put on the alfalfa plat on May 20. A view of this plat is shown in figure 2. On June 13 two of these were taken off and the other four left until July 2, when they were taken off and sold. Another lot of eight spring pigs, weighing an average of 51 pounds each, were put on the plat on July 6. As it was noticed that the alfalfa was being pastured too

[1] The analyses of the beets of the 1914 crop were made by the South Dakota Agricultural Experiment Station, at Brookings, S. Dak. All the samples each year were analyzed several days after the beets were dry, so that these figures are probably somewhat high.

closely, two of the hogs were taken off on July 25 and two more were removed on September 3, leaving only four to turn on the corn on September 22.

The average live weight kept on the alfalfa pasture during the season was 453.9 pounds, or at the rate of 1,815 pounds to the acre. The hogs, while they were on the alfalfa pasture, were given a daily ration of 2 pounds of shelled corn for each 100 pounds of live weight.

The total gain made by the hogs during the season of 121 days on the alfalfa was 457.5 pounds. The price received for the hogs at Newell was 7 cents per pound. The corn fed during this period cost $1.70 per 100 pounds at Newell. The net return per acre obtained from the hogs, using the Newell prices of pork sold and corn fed, was $41.44. Assuming that this plat yielded 3.69 tons of hay per acre,

FIG. 2.—Hogs on alfalfa pasture at the Belle Fourche Experiment Farm, June 14, 1914. Hogs pastured on alfalfa gave a net return of $41.44 per acre in 1914. (P-5013-W. I. A.)

the average yield of the other plats of the same age in this field, the price received for the alfalfa consumed by the hogs was $11.23 per ton. At the same time the local market price of alfalfa hay was $4.50 per ton.

HOGGING CORN.

The four hogs remaining on the alfalfa plat on September 22 were turned on the corn plat on that date and left until all the grain had been consumed. The hogs were on the corn 20 days and during this time made a total gain of 145.5 pounds. This gain at 7 cents a pound was worth $10.18, or $40.72 per acre for the corn. The estimated yield of corn on this plat was 34.8 bushels per acre. On the basis of this estimate the hogs paid $1.17 per bushel for the corn consumed.

The results obtained from this experiment since it was started in 1912 show that hogging is a decidedly profitable way to market alfalfa and corn on the project. The small amount of labor connected with this method of marketing crops is an important factor in its favor. Another point in its favor is the fact that less fertility is removed from the soil than would be the case if the crops were taken directly from the land and sold.

RATE OF SEEDING ALFALFA.

In the spring of 1913 a rate-of-seeding test with alfalfa was commenced. Fourteen different rates were used, varying from 2.5 pounds to 25 pounds per acre. Table V shows the rate of seeding, the number of plants per acre in the fall of 1913 and in the fall of 1914, the yield of each cutting, and the total yield for the season of 1914.

TABLE V.—*Rate-of-seeding tests with alfalfa at the Belle Fourche Experiment Farm, showing stand of plants, yields, etc.*

Plat No.	Seed per acre.	Tests begun in the spring of 1913.						Tests begun in the spring of 1914.			
		Thousands of plants per acre, fall of—		Yields per acre in 1914 (tons).				Thousands of plants per acre in—		Seed-producing plants.	Plants living in October.
		1913	1914	1st cutting.	2d cutting.	3d cutting.	Total.	June.	October.		
	Lbs.									*Per ct.*	*Per ct.*
1	2½	102	100	1.20	1.00	0.90	3.1	145	95	25	65
2	3	73	92	1.00	1.10	1.10	3.2	229	123	34	53
3	4½	97	111	1.30	1.30	1.00	3.6	283	136	27	48
4	6	114	137	1.20	1.30	.90	3.4	362	146	27	40
5	8	139	158	1.16	1.10	.60	2.8	429	148	23	34
6	10	135	171	1.00	.90	.70	2.6	411	155	18	37
7	11½	126	192	.19	1.04	.50	2.4	549	183	21	33
8	13	143	206	1.10	1.10	.70	2.9	636	224	20	35
9	15	156	206	1.10	.84	.50	2.4	681	192	20	28
10	16½	175	246	1.00	1.06	.40	2.4	736	204	19	27
11	18½	202	237	1.24	.76	.40	2.4	893	194	21	21
12	20½	210	244	.86	.70	.50	2.0	958	222	20	23
13	22½	227	282	.96	.96	.50	2.4	1,005	190	19	18
14	25	144	352	1.08	.74	.60	2.4	1,208	237	21	19

In the spring of 1914 this experiment was repeated. The ground used grew a crop of oats in 1913 and was fall plowed and double disked the same year. Just previous to planting, the ground was gone over with a spring-tooth harrow and leveled. The alfalfa was planted on May 7. The rate of seeding, the number of plants per acre in June and in October, 1914, and the percentage of seed-producing plants that survived the summer are also shown in Table V.

The best yields generally were obtained on the plats where a light rate of seeding was used. There was very little variation in the yields, but the indications are that a rate of seeding of 4½ to 6 pounds will give satisfactory results.

Table V shows that in the test begun in 1914 of the 4-pound seeding 40 per cent of the plants survived, while in the 25-pound seeding only 19 per cent lived. To secure a good stand of alfalfa a well-prepared seed bed is essential. For spring seeding the ground should be given a thorough disking just previous to seeding and the seeding should be done at a time when there is moisture enough in the soil to bring the seed up at once, so as to give the alfalfa at least an even chance with the weeds.

TIME AND METHOD OF SEEDING ALFALFA.

The experiment with the time and method of seeding alfalfa, reported in 1913, was repeated in 1914 and flax, oats, and barley were used as nurse crops in addition to wheat. Also, alfalfa was seeded after the grain crop was removed. The land used was in grain in 1913, fall plowed and disked, and in the spring of 1914 just previous to seeding the land was gone over with a spring-tooth harrow and leveled. The alfalfa in each case was planted at the rate of 10 pounds per acre. Nurse crops were planted at the rate of 5 pecks of wheat, 10 pecks of oats, 6 pecks of barley, and 3 pecks of flax. Table VI shows the gross returns per acre secured in 1914 in this experiment.

TABLE VI.—*Results obtained with alfalfa planted at different times and by different methods at the Belle Fourche Experiment Farm in 1914.*

Method of seeding.	Unit of yield.	Yield per acre.	Local market price.	Gross returns, per acre.
Planted without nurse crop:				
On May 8 (early)	Ton	1.62	$5.00	$8.10
On June 11 (late)	do	.98	5.00	4.90
In rows 21 inches apart		.36	5.00	1.80
Wheat as nurse crop:				
Cut for hay	Ton	2.18	5.00	10.90
Cut for grain	Bushel	30.03	.90	27.27
Planted on May 8 with nurse crop:				
Oats	do	54.8	.40	21.92
Barley	do	40.3	.60	24.18
Flax	do	14.7	1.50	22.05

The returns per acre all decidedly favor the use of grain as a nurse crop and indicate that early seeding is preferable to late seeding. The early seeded alfalfa required two cuttings and one extra irrigation, and the alfalfa seeded late without a nurse crop required the same number of irrigations as where grain was used as a nurse crop. The early seeded alfalfa was irrigated six times and the late seeded alfalfa four times. Alfalfa seeded with wheat as a nurse crop cut for hay was irrigated six times, the same as the early seeded alfalfa without a nurse crop. The alfalfa seeded with wheat, oats, barley, and flax as nurse crops cut for the grain was irrigated four times.

The yields of hay from different cuttings in 1914 from similar plantings of alfalfa made in 1913 are given in Table VII.

TABLE VII.— *Yields of hay in 1914 from three cuttings of alfalfa planted at different times and by different methods in 1913 at the Belle Fourche Experiment Farm.*

Method and time of planting.	Yield of hay per acre (tons).			
	First cutting.	Second cutting.	Third cutting.	Total.
Planted without nurse crop:				
On May 9 (early)	1.32	1.28	1.38	3.99
On June 5 (late)	1.27	1.06	1.14	3.47
Average of May and June plantings	1.29	1.17	1.26	3.73
In rows 21 inches apart	.96	.79	.88	2.63
With wheat as nurse crop:				
Cut for hay	1.07	1.17	1.22	3.51
Cut for grain	1.12	1.32	1.25	3.69

It will be seen from Table VII that there was a slight difference in favor of planting alfalfa without a nurse crop, but this difference was very small. From the two years' work in time and method of seeding alfalfa, the first year's return per acre has been decidedly in favor of using grain as a nurse crop. Where a nurse crop is used, greater care must be taken in irrigation. The last irrigation for the grain should be applied as near harvest time as possible, and the grain should be removed from the field immediately and the land irrigated again. In a dry fall another irrigation should be given after harvest, so as to insure as much growth as possible in the fall. For the spring seeding of alfalfa, a nurse crop appears to be desirable, both because of the greater crop return and in order to keep down weeds.

LATE-SUMMER SEEDING OF ALFALFA.

On August 5, 1913, a part of field A–III was planted to alfalfa. This ground had previously been in winter rye. The alfalfa was drilled in the rye stubble on August 5 and irrigated at once. The alfalfa came up promptly and made a good growth during the fall of 1913.

The first cutting in 1914 yielded at the rate of 2.5 tons per acre, more than half of which was volunteer rye. The weight of the second cutting was lost, but from the appearance of the crop it is estimated that the yield was as heavy as that from any of the older alfalfa plats. The third cutting yielded at the rate of 1.5 tons per acre, which was as good as the best alfalfa plats in the field.

This method of seeding alfalfa was repeated in 1914 on land that had previously grown a crop of winter wheat. The alfalfa was drilled in the wheat stubble August 1, irrigated at once, and again irrigated on September 19. A good stand was secured and the alfalfa made an unusually good growth.

There is a decided advantage in seeding alfalfa in late summer in grain stubble if a stand can be secured. Where alfalfa is seeded in the spring with a nurse crop, a lighter seeding of the grain is necessary in order to favor the alfalfa. In seeding alfalfa after the grain crop is removed, this difficulty is avoided. A good stand can be secured at this time with less seed and with more certainty than by seeding in the spring, either with or without a nurse crop. There is less danger of getting the seed in too deep and the ground can be irrigated at once without washing or baking the soil, while the seed will come up promptly and make a better germination than in the spring, when the soil is likely to be somewhat colder. Where the land is infested with gumbo weeds (*Iva axillaris*) this method of seeding is still more advantageous. The gumbo weed makes its most rapid growth in the spring and early summer. In late summer and fall it is dormant and does not interfere with the growth of the young alfalfa. Where a stand of alfalfa is once secured, this weed does not seriously interfere with the growth of the crop.

ALFALFA SEED PRODUCTION.

A 3-year-old alfalfa field containing 12 acres was used in an experiment in seed production in 1914. The first cutting was harvested for hay on June 24. The second cutting was left for seed. The seed crop was irrigated three times and was harvested on September 22 to 24. A side-delivery attachment was made for the mower, so as to avoid having the horses or mower go over the alfalfa after it was cut, thus shattering the seed. The alfalfa was put into small piles immediately after cutting. It is best, when possible, to cut the seed crop on a cloudy day and put it into piles at once, for the reason that the pods will not shatter nearly so much, the piles will settle better, and there is less danger of blowing in case of a storm.

The total yield of seed from 12 acres was 3,710 pounds, which when cleaned weighed 3,600 pounds, or at the rate of 5 bushels per acre. An analysis of the seed by the seed laboratory of the United States Department of Agriculture showed the seed to be 99.31 per cent pure, with a germination of 93 per cent. The crops harvested from this field in 1914 included 1 ton per acre of hay, worth $5, and 5 bushels of seed per acre, worth $45, the total gross returns being $50 per acre. The total cost per acre for all labor operations, including $1 a bushel for thrashing and 60 cents per acre for irrigation, operation, and maintenance charges, was $12.30. Thus, there was a net return from this field, exclusive of interest and taxes, of $37.70 per acre. From these results it appears that the heavy gumbo soil of the project is well adapted to the production of alfalfa seed.

EXPERIMENTS IN FALL IRRIGATION.

ALFALFA.

Fall irrigation of alfalfa was continued in 1914. Eight quarter-acre plats were used for this work. Four of the plats were irrigated on November 12, 1913. During the growing season of 1914 all plats were irrigated alike.

Table VIII gives the yield for each cutting and the total yield secured in 1914.

TABLE VIII.—*Results of the fall irrigation of alfalfa in Field A at the Belle Fourche Experiment Farm in 1914.*

Plat No.	Treatment.	Yield per acre (tons).			
		1st cutting.	2d cutting.	3d cutting.	Total.
A-III-23	Fall irrigated	2.01	1.48	1.18	4.67
A-III-24	Not irrigated in fall	2.12	1.76	1.28	5.16
A-II-29	Fall irrigated	1.34	1.06	.62	3.02
A-II-30	Not irrigated in fall	1.58	1.07	.80	3.45
A-II-31	Fall irrigated	1.56	1.34	1.26	4.16
A-II-32	Not irrigated in fall	1.44	1.34	1.20	3.98
A-II-33	Fall irrigated	1.40	1.12	1.10	3.62
A-II-34	Not irrigated in fall	1.42	1.07	1.04	3.53

Average yield, fall irrigation 3.86
Average yield, normal irrigation 4.03

There was a slight but probably insignificant difference in favor of the plats not fall irrigated. The only obvious difference was that the fall-irrigated plats made a better growth early in the spring than those not fall irrigated. This was also very noticeable in the spring of 1913 on alfalfa irrigated in the fall of 1912. In the two years' trial there has been no increase in yield that could be attributed to fall irrigation, but each year there have been late fall rains, so that the difference in soil moisture has not been very great. As long as the fall irrigation has no detrimental effect on the alfalfa, it appears desirable to irrigate in a dry fall, in order to start the alfalfa early in the spring.

OTHER CROPS.

Experiments in fall irrigation with oats, beets, flax, potatoes, barley, corn, and wheat were commenced in the fall of 1913. These experiments include seven spring-planted crops grown in duplicate quarter-acre plats. The land was fall plowed in 1913 and half of the plats were irrigated on November 11, 1913. Table IX shows the average yields secured in 1914.

TABLE IX.—*Average yields of crops on duplicate quarter-acre plats in the fall-irrigation experiment at the Belle Fourche Experiment Farm in 1914.*

Crop.	Average yield per acre.		Increase in favor of fall irrigation.
	Fall irrigated.	Not fall irrigated.	
Corn.....bushels..	49.6	49.3	0.3
Beets.....tons..	8.1	8.3	— .2
Potatoes.....bushels..	149.1	165.8	—16.7
Wheat.....do....	30.0	21.9	8.1
Oats.....do....	43.4	43.9	— .5
Barley.....do....	27.9	27.3	.6
Flax.....do....	13.7	16.1	— 2.4

The only crop that showed a marked and consistent increase in yield in favor of fall irrigation was wheat, of which the average was increased by 8.1 bushels per acre by fall irrigation. With all the other crops the differences in yield were negligible, except that the stover yield of corn was very nearly doubled on the plats which were not fall irrigated. Greater differences might be found in seasons following very dry winters. The experiment will be continued.

VARIETY TEST OF CORN.[1]

In 1914 eight varieties of corn were tested on both dry land and irrigated land. They all failed to produce a crop of grain on the dry land. The yields obtained on irrigated land are shown in Table X, in which air-dry weights of grain are given. The varieties were planted in triplicate plats, 2 rows wide and 132 feet long.

TABLE X.—*Average yield of eight varieties of corn in 1913 and 1914 at the Belle Fourche Experiment Farm.*

Variety.	1913		1914		Average yield.
	Date of maturity.	Yield per acre.	Date of maturity.	Yield per acre.	
		Bushels.		*Bushels.*	*Bushels.*
Marten's White Dent	Sept. 11	60.4	Sept. 22	45.4	52.9
Lyman's White Cap Dent	.....	.....	Sept. 15	41.1	.....
U. S. Selection No. 133	Sept. 13	56.2	Sept. 28	39.0	47.6
Payne's White Dent	Sept. 11	55.3	Sept. 25	37.4	46.3
Disco Dent	Sept. 15	45.5	Sept. 28	35.9	40.7
Brown County Yellow Dent	Sept. 6	51.2	Sept. 20	34.7	42.9
Ardmore Dent	...do....	49.2	...do....	34.4	41.8
Northwestern Dent	Sept. 4	56.2	Sept. 15	31.5	43.8

Marten's White Dent gave the best yields per acre. All the other varieties occupy the same relative positions as in 1913 except Northwestern Dent and Brown County Yellow Dent. In 1914 the

[1] In cooperation with the Office of Corn Investigations, Bureau of Plant Industry.

Northwestern Dent yielded the lowest of all the varieties tested, but it was the first to mature. The yields of all varieties were much lower in 1914 than in 1913. This was due in part to the use of poorer land and in part to late planting.

SPACING DISTANCE OF CORN.

To determine a satisfactory distance of spacing corn under irrigation, the following distances of planting were tried in 1914: Seven inches, 10 inches, 14 inches, 17 inches, and 21 inches in the row. The rows were 42 inches apart, which is the regular distance. The test was conducted on triplicate plats. The average yields obtained are given in Table XI.

TABLE XI.—*Average yields of corn planted at different distances within the row at the Belle Fourche Experiment Farm in 1914.*

Distance planted.	Average yield per acre.		Ratio of grain to stover.
	Grain.	Stover.	
	Bushels.	*Tons.*	
7 inches	36.00	1.53	1 : 1.10
10 inches	39.36	1.16	1 : .84
14 inches	41.33	1.23	1 : .83
17 inches	40.63	1.13	1 : .78
21 inches	38.30	1.06	1 : .78

There was comparatively little difference in the yields. In the 7-inch planting the yield was noticeably lower and the quality of the corn was inferior, the ears being mostly nubbins. The most desirable distances, both as to quality of corn and as to yield per acre, were 14 and 17 inches. A thicker planting than 14 inches has a tendency to produce a larger number of small ears, making the husking operation much more expensive.

ORCHARD TREES AND SMALL FRUITS.

In the spring of 1914 several varieties of apples, plums, and cherries were planted. Two-year-old stock was used, and all varieties did well the first season. The varieties planted are listed below.

Apples.—Malinda, Duchess, Longfield, Whitney No. 20, Jonathan, Transcendent, Day, King David, Milwaukee, Florence, Northwestern Greening, McIntosh, Pewaukee, and Wealthy.

Plums.—Wolf, De Soto, Forest Garden, Surprise, and Savoy.

Cherries.—Richmond and Compass.

These varieties were recommended by the Office of Pomology to determine which varieties would be suitable to the locality.

The following varieties of small fruits were planted in the spring of 1914:

Raspberries.—Clark, Louden, Sunbeam, Cuthbert, and Marlboro.
Blackberries.—Snyder, Briton, Eldorado, and Stone.
Gooseberries.—Carrie and Smith.
Currants.—White Grape, Fay, Perfection, Red Dutch, and Prince Albert.
Strawberries.—Clyde, Haverland, Dunlap, Crescent, Aroma, and Warfield.

Good stands were secured from all the varieties except the blackberries. No recommendation as to varieties can be made from the one year's work.

Land for planting trees, shrubs, or small fruit should be plowed and disked in the fall. Planting from April 15 to April 30 is preferable to later planting. Great care should be used not to expose the roots to wind and sun while planting. The ground should be tamped firmly around the roots and irrigated as soon as the planting is completed.

TREES AND SHRUBS.

All the trees on the experiment farm except the jack pine and bull pine came through the winter of 1913–14 without any winterkilling. The jack pines winterkilled very badly and those surviving made very little growth. While a few of the bull pines winterkilled, those that did come through the winter made a good growth during the summer. In the spring some 2,000 native cottonwoods were planted, and these all made excellent growth. Much better success was obtained with the native cottonwoods than with any that had been bought from nurseries heretofore.

The varieties of trees now grown in the irrigated forest strip are cottonwoods, green ash, white elm, Russian oleaster, Siberian pea tree, honey locust, box elder, white willows, golden willows, jack pine, and bull pine. Some species secured from the Office of Foreign Seed and Plant Introduction have been tried. Among the most promising is a Chinese elm, S. P. I. No. 22975, and a willow, S. P. I. No. 24418. The Chinese elm seems to be perfectly hardy and grows much more rapidly than the common white elm.

The following ornamental trees and shrubs were planted on the grounds of the farmstead in 1914: Soft maple, European mountain ash, Norway poplar, Carolina poplar, Lombardy poplar, golden willow, laurel-leafed willow, diamond willow, buffalo berry, basswood, hackberry, buckthorn, Black Hills spruce, Colorado blue spruce, dwarf mountain pine, mock orange, Tartarian honeysuckle, lilac, high-bush cranberry, common snowball, Siberian dogwood, hydrangea, common barberry, purple barberry, Japanese barberry, spirea van houte, *Spiræa opulifolia*, *Spiræa sorbifolia*, yellow currant, golden elder, and common elder.

COOPERATION.

Much of the work of the experiment farm is done in cooperation with other offices of the Bureau of Plant Industry and with the Forest Service. The nature and extent of this work is here indicated.

Biophysical laboratory.—The Biophysical Laboratory cooperates in all climatological and physical observations. This work includes measurements of rainfall, wind velocity, evaporation, temperature, and soil moisture.

Dry-land agriculture.—The Office of Dry-Land Agriculture uses about 20 acres of land above the canal, divided into one-tenth-acre plats, for rotation and tillage experiments. These experiments include continuous cropping by ordinary methods and moisture-conservation methods compared with alternate cropping and summer-fallowing, a comparison of various 3-year rotations, and crop rotations for the conservation of humus. An assistant in dry-land agriculture is detailed to the farm to supervise this work.

Cereal investigations.—This office has charge of the plant-breeding work and variety testing of small grains. An assistant detailed by the Office of Cereal Investigations has charge of these experiments. Approximately 20 acres of land are used.

Alkali and drought-resistant plant investigations.—This office does variety-testing and plant-breeding work with forage crops, including alfalfa, brome-grass, western wheat-grass, sorghum, and millet, and conducts studies of the water requirements of the different varieties and strains tested. About 15 acres of land are devoted to the work, and an assistant is detailed to supervise the experiments.

Corn investigations and sugar-plant investigations.—The Offices of Corn Investigations and of Sugar-Plant Investigations cooperate in the work with corn and sugar beets, respectively, each office using about 2 acres of land. The work with these crops includes variety testing and tillage experiments.

Forest service.—The United States Forest Service cooperates in the testing of trees for wood-lot and windbreak purposes. About 9 acres of land are used for this purpose.

Approved:
WM. A. TAYLOR,
Chief of Bureau.

JUNE 15, 1915.

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